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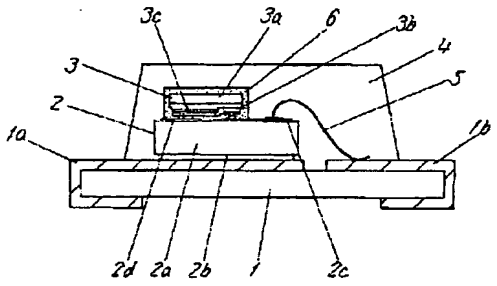
(54) SEMICONDUCTOR LIGHT EMITTING DEVICE AND MANUFACTURING METHOD THEREFOR

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a semiconductor light emitting device for obtaining pure white light emission by optimizing the thickness of a resin layer for wavelength converting the light from the main light extracting surface of a flip-chip light emitting element into white color.

SOLUTION: An optical light emitting device having a flip-chip semiconductor light emitting element 3 is obtained by laminating a compound semiconductor on the surface of a transmissive board 3a, forming p-type side and n-type side electrodes 3c, 3b on the surface of the semiconductor, conductively loading the electrodes 3c, 3d on a surface, and forming the rear surface of the board as a main light extracting surface. In this case, at least the main light extracting surface of the board 3a is covered with the transmissive wavelength conversion layer 6 containing wavelength conversion phosphor, and the surface of the layer 6 is polished and created so as to become parallel to the main light extracting surface.



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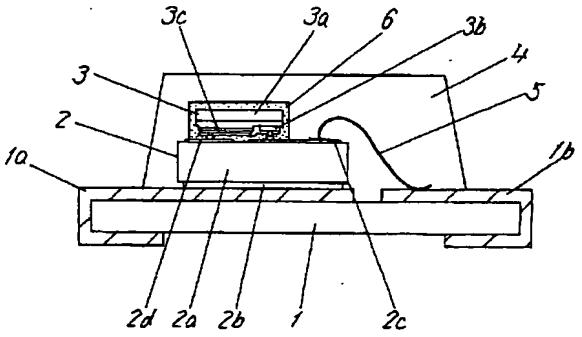
最終頁に続く

(54)【発明の名称】　半導体発光装置及びその製造方法

(57)【要約】
【課題】　フリップチップ型の発光素子の主光取出し面からの光を白色に波長変換する樹脂層の層厚を最適化して純粋な白色発光が得られる半導体発光装置及びその製造方法を提供すること。
【解決手段】　光透過性の基板３ａの表面に化合物半導体を積層し、この化合物半導体の表面側にｐ側及びｎ側の電極３ｃ，３ｂを形成し、これらのｐ側及びｎ側の電極３ｃ，３ｂを実装面に導通搭載し且つ前記基板の裏面側を主光取出し面としたフリップチップ型の半導体発光素子３を含む半導体発光装置であって、少なくとも基板３ａの主光取出し面を、波長変換用の蛍光物質を含有した光透過性の波長変換層６によって被覆し、この波長変換層６の表面を主光取出し面と平行となるように研磨創成する。



【特許請求の範囲】
【請求項１】　光透過性の基板の表面に化合物半導体を積層し、前記化合物半導体の表面側にｐ側及びｎ側の電極を形成し、前記ｐ側及びｎ側の電極を実装面に導通搭載し且つ前記基板の裏面側を主光取出し面としたフリップチップ型の半導体発光素子を含む半導体発光装置であって、少なくとも前記基板の主光取出し面を、波長変換用の蛍光物質を含有した光透過性の波長変換層によって被覆し、前記波長変換層の表面を前記主光取出し面と平行となるように研磨創成したことを特徴とする半導体発光装置。
【請求項２】　前記発光素子は、前記基板として透明のサファイアを用い且つ前記化合物半導体をＧａＮ系化合物半導体として構成したことを特徴とする請求項１記載の半導体発光装置。
【請求項３】　請求項１または２に記載の半導体発光装置の製造方法であって、
（１）前記発光素子の基板が上を向く姿勢として前記ｐ側及びｎ側の電極をそれぞれ導通基板側に導通搭載する工程と、
（２）少なくとも前記基板が上を向いた面として形成される主光取出し面を含めて前記発光素子の周りを、波長変換用の蛍光物質を含有する樹脂材料によって被膜する工程と、
（３）前記樹脂材料の上面を前記基板の主光取出し面と平行となるように研磨する工程と、
（４）前記導通基板をダイシングしてチップ化する工程とを含むことを特徴とする半導体発光装置の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、たとえば青色発光の発光ダイオードによる発光を波長変換して白色発光を得るようにした半導体発光装置に係り、特にフリップチップ型の発光素子を用いてその主光取出し面からの白色発光の色度を最適化した半導体発光装置及びその製造方法に関する。
【０００２】
【従来の技術】青色発光の発光ダイオード（以下、「ＬＥＤ」と記す）は、近来になって、ＧａＮ，ＧａＡｌＮ，ＩｎＧａＮ及びＩｎＡｌＧａＮ等のＧａＮ系化合物半導体を利用することによって、発光輝度の高い製品が得られるようになった。そして、この青（Ｂ）のＬＥＤと旧来からの赤（Ｒ），緑（Ｇ）発光のＬＥＤとの組合せにより、これらのＬＥＤの３個を１ドットとする高画質のフルカラー画像の形成が可能となった。
【０００３】ＬＥＤの分野では、フルカラー対応には光の三原色のＲ，Ｇ，Ｂ（青）が必要であるから、これらの発光色のＬＥＤのより一層の開発と改良が主である。その一方で、たとえばＲ，Ｇ，Ｂの合成によってしか得られない白色発光を単一のＬＥＤで達成しようとする試みも既になされている。このような試みの一つとして、たとえば特開平７－９９３４５号公報に開示されたものがある。
【０００４】この公報に記載のＬＥＤは、図４の概略図に示すように、発光チップ５０を搭載するリードフレーム５１のマウント部５１ａを含めて樹脂（図示せず）によって封止するいわゆるＬＥＤランプのタイプとしたものである。そして、発光チップ５０の発光波長を変えて異なった発光色とするために、発光チップ５０の周りのマウント部５１ａを蛍光物質を含んだ樹脂５２で封止した構成を持つ。すなわち、旧来のＬＥＤランプでは発光チップを搭載するリードフレームの先端部を含めて被覆するとともにレンズ機能も兼ねるエポキシ樹脂の単層で封止していたものに代えて、発光チップ周りに波長変換用の樹脂層を形成し、その周りをエポキシ樹脂で封止したものである。
【０００５】また、図４のマウント部に発光チップを搭載して砲弾型に樹脂封止するＬＥＤランプに代えて、本願出願人は、サブマウント素子の上にｐ側及びｎ側の電極を下向きにして実装したフリップチップ型の発光素子の周りを蛍光物質を含む樹脂パッケージで封止した白色発光の半導体装置を提案し、特願平１１－３７８８号として出願した。この出願に係る半導体発光装置においても、発光素子からの青色発光を蛍光物質によって波長変換して白色発光が可能である。
【０００６】
【発明が解決しようとする課題】ＬＥＤランプの場合では、発光チップ５０を搭載するマウント部５１ａの内面を光反射面として利用するので、図示の例のようにマウント部５１ａをすり鉢状とすることが有効である。この場合、樹脂５２はディスペンサによってマウント部５１ａに注入されるので、その厚さを高精度で制御することは非常に難しく、発光チップ５０の上面と蛍光物質を含んだ樹脂５２の表面との間の層厚Ａを設定された所定値にすることは現状では不可能である。
【０００７】ここで、発光チップ５０がたとえばサファイアを基板とするＧａＮ系化合物半導体を利用した半導体発光素子であると、基板を上向きにしてその上面が最も発光輝度が高い主光取出し面となる。一方、発光チップ５０の上面に被さる蛍光物質を含む樹脂５２の層厚Ａが製品ごとにばらつくと、発光チップ５０からの光の変換効率が不均一となって目的とする純粋な白色発光は得られない。すなわち、樹脂５２の層厚Ａが適正値より大きいほど発光チップ５０からの青色発光が黄緑色に変換される割合が高くなって緑っぽい発光色となり、層厚Ａが適正値より小さいと青色がかった発光色となる。このように、リードフレーム５１のマウント部５１ａに発光チップ５０を搭載してディスペンサによって蛍光物質を含む樹脂５２を充填する方式では、蛍光物質による変換効率の一様化が達成できないので、白色発光の半導体発

光装置としては適切でない面がある。

【０００８】一方、本願出願人による先の出願のフリップチップ型の発光素子周りを蛍光物質含有の樹脂パッケージで封止するものでは、ウエハ状態にある基板材に発光素子を実装搭載した後にこの発光素子の周囲全体を包み込む金型をセットし、この金型に樹脂を注入することで樹脂パッケージを形成できる。このような樹脂パッケージの形成方法では、樹脂パッケージの厚さは金型の形状によって一様に決められる。したがって、ダイシング後の最終製品では、発光素子の周りに金型により創成されたほぼ一様な厚さの樹脂パッケージが形成されるはずである。

【０００９】しかしながら、たとえばエポキシ樹脂を生地として各種の蛍光物質を混入したものを材料とするので、蛍光物質の混入濃度や粒子の大きさによって金型による最適な成形条件はさまざまに変わる。たとえば、樹脂の溶融温度や徐冷硬化の関係などから硬化成形後の樹脂パッケージの肉厚に微妙な影響を与え、成形された樹脂パッケージの肉厚を全ての製品について設計値にすることは非常に困難である。

【００１０】このようにフリップチップ型の発光素子を蛍光物質含有の樹脂で封止する場合では、図４で示したリードフレーム５１のマウント部５１ａに樹脂をディスペンサで注入する場合に比べると、発光素子の主光取出し面を被膜する樹脂の厚さをある程度一様化できる。しかしながら、フリップチップ型の発光素子であっても、蛍光物質を含む樹脂の厚さが製品ごとに微妙に異なることは避けられない。そして、蛍光物質を含む樹脂の厚さが波長変換率に大きく影響するので、金型で樹脂パッケージを形成しただけでは、純粋な白色発光の製品の製造という面からは歩留まりが低下しやすい。

【００１１】本発明は、フリップチップ型の発光素子の主光取出し面からの光を白色に波長変換する樹脂層の層厚を最適化して純粋な白色発光が得られる半導体発光装置及びその製造方法を提供することを目的とする。

【００１２】

【課題を解決するための手段】本発明は、光透過性の基板の表面に化合物半導体を積層し、前記化合物半導体の表面側にｐ側及びｎ側の電極を形成し、前記ｐ側及びｎ側の電極を実装面に導通搭載し且つ前記基板の裏面側を主光取出し面としたフリップチップ型の半導体発光素子を含む半導体発光装置であって、少なくとも前記基板の主光取出し面を、波長変換用の蛍光物質を含有した光透過性の波長変換層によって被覆し、前記波長変換層の表面を前記主光取出し面と平行となるように研磨創成したことを特徴とする。

【００１３】また、このような半導体発光装置を製造するための本発明のの製造方法は、（１）前記発光素子の基板が上を向く姿勢として前記ｐ側及びｎ側の電極をそれぞれ導通基板側に導通搭載する工程と、（２）少なくとも前記基板が上を向いた面として形成される主光取出し面を含めて前記発光素子の周りを、波長変換用の蛍光物質を含有する樹脂材料によって被膜する工程と、（３）前記樹脂材料の上面を前記基板の主光取出し面と平行となるように研磨する工程と、（４）前記導通基板をダイシングしてチップ化する工程とを含むことを特徴とする。

【００１４】

【発明の実施の形態】請求項１に記載の発明は、光透過性の基板の表面に化合物半導体を積層し、前記化合物半導体の表面側にｐ側及びｎ側の電極を形成し、前記ｐ側及びｎ側の電極を実装面に導通搭載し且つ前記基板の裏面側を主光取出し面としたフリップチップ型の半導体発光素子を含む半導体発光装置であって、少なくとも前記基板の主光取出し面を、波長変換用の蛍光物質を含有した光透過性の波長変換層によって被覆し、前記波長変換層の表面を前記主光取出し面と平行となるように研磨創成したことを特徴とする半導体発光装置であり、主光取出し面を被覆する波長変換層の厚さを均一化できるので主光取出し面からの光の波長変換率を一様化でき色度むらのない発光が得られるという作用を有する。

【００１５】請求項２に記載の発明は、前記発光素子は、前記基板として透明のサファイアを用い且つ前記化合物半導体をＧａＮ系化合物半導体として構成したことを特徴とする請求項１記載の半導体発光装置であり、ＧａＮ系化合物半導体の高輝度の青色発光を蛍光物質含有の波長変換層によって白色発光に変換して発光させるという作用を有する。

【００１６】請求項３に記載の発明は、請求項１または２に記載の半導体発光装置の製造方法であって、（１）前記発光素子の基板が上を向く姿勢として前記ｐ側及びｎ側の電極をそれぞれ導通基板側に導通搭載する工程と、（２）少なくとも前記基板が上を向いた面として形成される主光取出し面を含めて前記発光素子の周りを、波長変換用の蛍光物質を含有する樹脂材料によって被膜する工程と、（３）前記樹脂材料の上面を前記基板の主光取出し面と平行となるように研磨する工程と、（４）前記導通基板をダイシングしてチップ化する工程とを含むことを特徴とする半導体発光装置の製造方法であり、樹脂材料を主光取出し面と平行になるように研磨して波長変換層を形成することで色度むらのない波長変換光が得られるとともに、研磨量を調整することで波長変換度も調節でき発光色の色調の調整も自在に行えるという作用を有する。

【００１７】以下、本発明の実施の形態について図面に基づき説明する。

【００１８】図１は本発明の一実施の形態による半導体発光装置の概略縦断面図である。

【００１９】図示のように、本発明の半導体発光装置は、実装基板１と、その上に搭載したサブマウント素子

２と、その上に搭載した発光素子３と、これらのサブマウント素子２及び発光素子３を含めて封止した透明の樹脂パッケージ４とを主な部材としたものである。そして、発光素子３の周りには、後述するように、白色化のための蛍光物質の波長変換層がそれぞれ形成されている。

【００２０】実装基板１は絶縁性であって、従来のフリップチップ型の半導体発光素子と同様にウエハ状態の基板材にスリットを切開したものを用い、このスリットを通して電極１ａ，１ｂをメッキ法によって実装基板１の表裏両面にかけて形成したものである。また、樹脂パッケージ４はサブマウント素子２及び発光素子３の実装及びワイヤボンディングの後にウエハ状態の基板材の表面を樹脂で封止し、最終工程のダイシングによって図示の形状の実装基板１及び樹脂パッケージ４として創成される。

【００２１】サブマウント素子２はｎ型のシリコン基板２ａを用いたもので、このシリコン基板２ａの底面には実装基板１の電極１ａに導通搭載されるｎ電極２ｂを形成している。また、シリコン基板２ａの上面には、このシリコン基板２ａの一部に形成したｐ型半導体領域に接触するｐ側電極２ｃとｎ型半導体領域に接触するｎ側電極２ｄがそれぞれ形成されている。

【００２２】発光素子３は、従来技術の項で述べたＧａＮ系化合物半導体を利用した高輝度の青色発光のＬＥＤである。この発光素子３は、サファイアを素材とした基板３ａの表面に、たとえばＧａＮのｎ型層，ＩｎＧａＮの活性層及びＧａＮのｐ型層を積層したものである。そして、従来周知のように、ｐ型層の一部をエッチングしてｎ型層を露出させ、この露出したｎ型層の表面にｎ側電極３ｂを形成し、ｐ型層の表面にはｐ側電極３ｃを形成し、ｎ側電極３ｂをサブマウント素子２のｐ側電極２ｃに及びｐ側電極３ｃをサブマウント素子２のｎ側電極２ｄにそれぞれバンプ電極を介して接合している。

【００２３】更に、サブマウント素子２のｐ側電極２ｃと実装基板１の電極１ｂとの間にはワイヤ５がボンディングされている。なお、実装基板１は電子機器等の配線基板に実装され、それぞれの電極１ａ，１ｂをこの配線基板の配線パターンに実装搭載することにより、発光素子３をサブマウント素子２を介して電源回路側に導通させる。また、樹脂パッケージ４は、従来からＬＥＤランプの分野で使用されている光透過性のエポキシ樹脂を素材としたものである。

【００２４】ここで、本発明では、発光素子３の周りを波長変換層６で被覆し、この波長変換層６を樹脂パッケージ４で封止して保護している。波長変換層６は先に説明した特願平１１－３７８８号の出願明細書にも記載しているように、発光素子３の青色発光を白色に変換するための蛍光物質をエポキシ樹脂に混入したものである。この青色発光を白色発光に変換する蛍光物質は、発光素子３の発光色である青色と補色の関係を持つものであればよく、蛍光染料，蛍光顔料，蛍光体などが利用でき、たとえば$(Y, Gd)_3(Al, Ga)_5O_{12}:Ce$などが好適である。

【００２５】波長変換層６は発光素子３からの青色発光を白色発光に変換するが、その変換効率は波長変換層６の厚さに依存する。すなわち、前述のように波長変換層６が所定値よりも厚いと緑がかった発光色となり、所定値より薄いと青みが強い発光色となり、厚さが異なる部分の発光観測面からの光は白色光から外れた色調となりやすい。したがって、波長変換層６の厚さは発光素子３の全方位で同じ厚さであって最適な効率で白色光に変換できるように設定することが好ましい。しかしながら、先に説明したように、現状の製造技術の面からは波長変換層６を一様な厚さに成形することは非常に困難である。

【００２６】一方、透明のサファイアを基板３ａとするＧａＮ系化合物半導体による発光素子３では、ＩｎＧａＮの活性層からの発光の大部分は基板３ａの上面から放出される。すなわち、図１において基板３ａの上面が主光取出し面となり、この主光取出し面からの青色発光を純粋な白色に変換すれば、全体として良好な白色発光が得られる。無論、波長変換層６は主光取出し面だけでなく基板３ａの側面からあるいはｐ側，ｎ側の電極３ｃ，３ｂの形成部分からも光は放出されるが、目的とする発光方向は図１において上向きであり、これらの側面や電極形成面側からの発光は使途への貢献度は比較的小さい。したがって、主光取出し面からの光を純粋な白色発光とすれば半導体発光装置として満足なものが得られ、この主光取出し面すなわちサファイアの基板３ａの上面を被覆している部分の波長変換層６の厚さを均等にすれば色度むらのない発光が得られることになる。なお、波長変換層６は発光素子３の側面及び電極形成面側も含めて封止しているので、発光素子３の全体からの光を白色に波長変換されることに変わりはない。

【００２７】ここで、波長変換層６をその中に含んだ蛍光物質が青色発光により励起されて白色発光として観察される。この場合、波長変換層６の厚さが波長変換率を一義的に決めるので、発光素子３の表面を被覆する波長変換層６の厚さが均一であること及びその厚さが最適値であるかが重要な因子となる。これに対し、本発明者らは波長変換層６を形成した後にその表面を研磨すれば主光取出し面との間の厚さを一様化できることを知見し、さらにその最適厚さを経験的に導出した。図２にサブマウント素子２と発光素子３とによる複合化素子の製造工程の概略を順に示す。

【００２８】図２において、予めダイシングによってチップ化した発光素子３をサブマウント素子用の基板材１１に予め形成したバンプ電極１１ａ，１１ｂにｐ側及びｎ側の電極３ｃ，３ｂを位置合わせし、バキュームヘッ

ドによって発光素子３を基板材１１に実装してチップ接合する（同図（ａ））。次いで、蛍光物質を含んだ樹脂材料１２を塗布または金型によって発光素子３の全体を被覆する（同図（ｂ））。この樹脂材料１２の塗布または金型による形成では、図中のように表面に凹凸ができたりして一様な平坦度が得られないので、研磨ヘッド１３によって樹脂材料１２の上面を研磨する（同図（ｃ））。最後に、ダイサー１４によって基板材１１をダイシングすることによって図１に示したサブマウント素子２と発光素子３とによる複合化素子が得られる。

【００２９】このような製造工程では、基板材１１の上に発光素子３の基板３ａの上面が水平姿勢となるように実装しておき、研磨工程で研磨ヘッド１３を高精度で水平回転させる。これにより研磨工程の後では、基板３ａの上面と研磨された後の樹脂材料すなわち波長変換層６の上面とは平行な関係となり、波長変換層６の肉厚を高精度で一様化できる。したがって、発光素子３の主光取出し面の全体からの光は、全て一様な波長変換効率を受けて白色に波長変換され、色度が一様な白色発光が得られる。

【００３０】図３は以上の研磨工程によって形成された波長変換層６の層厚と色度座標ｘとの関係を実測によって得たデータである。

【００３１】波長変換層６の層厚は４０μｍ～６０μｍの間で変えたものを製作し、図１に示したＧａＮ系化合物半導体による発光素子３を点灯させて色度座標ｘをプロットした。このプロットから明らかなように、波長変換層６が厚くなるにつれてｘ座標の座標値はほぼリニア増加していき、波長変換層６の厚さｔとｘ座標の座標値との間に明瞭な相関があることが判る。このことから、波長変換層６の厚さｔを調整することによって、色度座標の座標ｘ値を設定することができ、その結果色度の調整も可能となる。

【００３２】また、図３におけるプロット線図により得られたデータによれば、色度座標値のｘ値の経験式（実験式）はｘ＝０．００３５ｔ＋０．０８６７であった。したがって、予め目標とする色度座標のｘ座標に対して波長変換層６の厚さｔを容易に導き出すことができ、所望の白色発光を得ることができる。なお、色度座標におけるｙ座標については、青色発光の発光素子の発光波長が支配的であり、白色発光への相関は無視できる。

【００３３】以上のように、発光素子３の主光取出し面を被覆する波長変換層６の層厚を均一化するように研磨するので、主光取出し面からの光の全てについて同じ波長変換の条件を加えることができ、色度を一様化した良好な白色発光が得られる。また、図２の（ｃ）での研磨工程による樹脂材料１２の研磨量を調整することで、白色発光の色調も自在に調節でき、用途に応じた発光源として最適に利用することができる。

【００３４】

【発明の効果】本発明では、発光素子の主光取出し面を被覆する波長変換層の厚さを均一化できるので主光取出し面からの光の波長変換率を一様化でき、色度むらのない発光が得られる。また、波長変換層の厚さを研磨によって調整するので、層厚を任意に設定でき色度も自在に調節でき、青色発光の発光素子を使用する場合では純粋な白色発光が得られ、従来の蛍光灯等に代わる光源として利用できる。

【図面の簡単な説明】

【図１】本発明の一実施の形態による半導体発光装置の概略縦断面図

【図２】サブマウント素子と発光素子とによる複合化素子の製造工程を順に示す概略図

【図３】本発明の半導体発光装置における波長変換層の層厚と色度座標のｘ座標値との関係を示すプロット線図

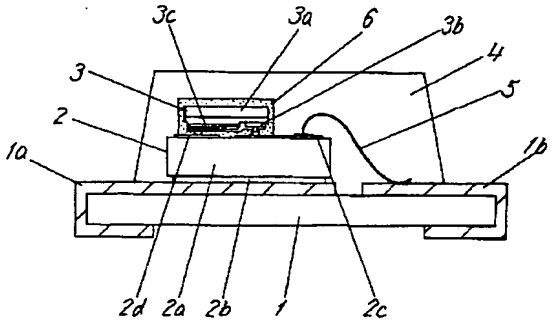
【図４】青色発光の発光素子を樹脂に蛍光物質を混入した波長変換層によって封止した従来例であって、（ａ）はその概略縦断面図

（ｂ）は概略平面図

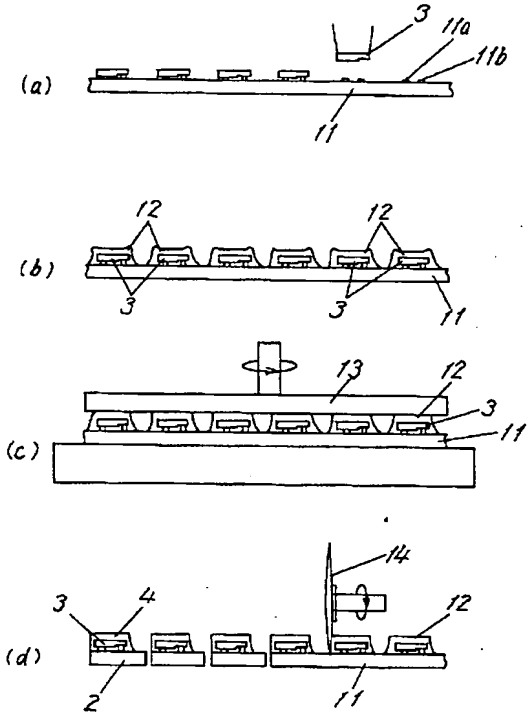
【符号の説明】

１　実装基板
１ａ，１ｂ　電極
２　サブマウント素子
２ａ　シリコン基板
２ｂ　ｎ電極
２ｃ　ｐ側電極
２ｄ　ｎ側電極
３　発光素子
３ａ　基板
３ｂ　ｎ側電極
３ｃ　ｐ側電極
４　樹脂パッケージ
５　ワイヤ
６　波長変換層
１１　基板材
１１ａ，１１ｂ　バンプ電極
１２　樹脂材料
１３　研磨ヘッド
１４　ダイサー

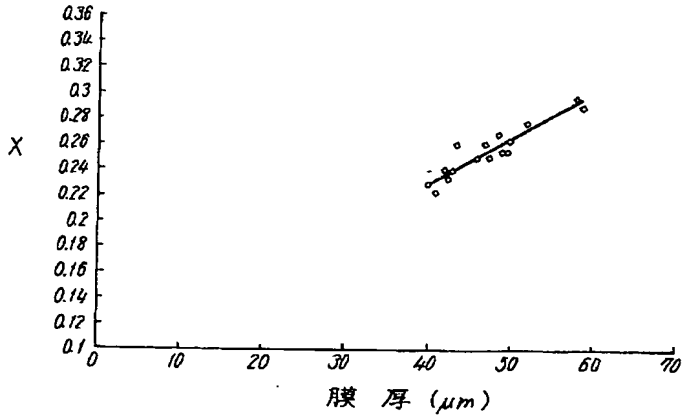
【図1】


3c
3a
6
3b
4
3
5
2
1a
1b
2d
2a
2b
1
2c

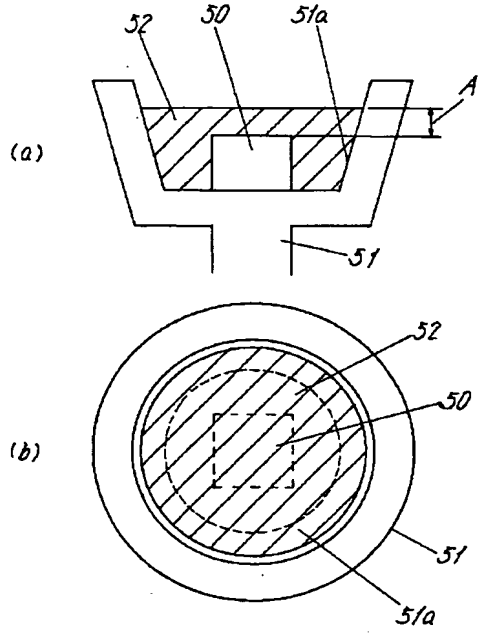
【図2】


(a)
3
11a
11b
11
(b)
12
12
3
3
11
(c)
13
12
3
11
(d)
14
3
4
12
2
11

【図3】


X
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0
10
20
30
40
50
60
70
膜 厚 (μm)

【図4】


(a)
52
50
51a
A
51
(b)
52
50
51
51a

フロントページの続き

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(54) **SEMICONDUCTOR LIGHT EMITTING DEVICE AND MANUFACTURING METHOD THEREFOR**

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a semiconductor light emitting device for obtaining pure white light emission by optimizing the thickness of a resin layer for wavelength converting the light from the main light extracting surface of a flip-chip light emitting element into white color.
SOLUTION: An optical light emitting device having a flip-chip semiconductor light emitting element 3 is obtained by laminating a compound semiconductor on the surface of a transmissive board 3a, forming p-type side and n-type side electrodes 3c, 3b on the surface of the semiconductor, conductively loading the electrodes 3c, 3d on a surface, and forming the rear surface of the board as a main light extracting surface. In this case, at least the main light extracting surface of the board 3a is covered with the transmissive wavelength conversion layer 6 containing wavelength conversion phosphor, and the surface of the layer 6 is polished and created so as to become parallel to the main light extracting surface.

CLAIMS

[Claim(s)]
[Claim 1] Carry out the laminating of the compound semiconductor to the front face of the substrate of light transmission nature, and the electrode by the side of p and n is formed in the front-face side of said compound semiconductor. It is semi-conductor luminescence equipment containing the semi-conductor light emitting device of the flip chip mold which carried out flow loading of the electrode by the side of said p and n at the component side, and made the rear-face side of said substrate the main light drawing side. Semi-conductor luminescence equipment characterized by having covered the main light drawing side of said substrate with the wavelength conversion layer of the light transmission nature containing the fluorescent material for wavelength conversion at least, and carrying out polish generating of the front face of said wavelength conversion layer so that it may become parallel to said main light drawing side.

[Claim 2] Said light emitting device is semi-conductor luminescence equipment according to claim 1 characterized by constituting said compound semiconductor as a GaN system compound semiconductor, using the sapphire of transparence as said substrate.
[Claim 3] The manufacture approach of the semi-conductor luminescence equipment according to claim 1 or 2 characterized by providing the following (1) The process which carries out flow loading of the electrode by the side of said p and n as a position in which the substrate of said light emitting device turns to a top at a flow substrate side, respectively (2) The process which carries out the coat of the surroundings of said light emitting device with the resin ingredient containing the fluorescent material for wavelength conversion including the main light drawing side formed as a field said substrate turned [field] to the top at least (3) The process which grinds the top face of said resin ingredient so that it may become parallel to the main light drawing side of said substrate (4) The process which carries out the dicing of said flow substrate, and chip-izes it

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the semi-conductor luminescence equipment which was applied to the semi-conductor luminescence equipment which carries out wavelength conversion of the luminescence by the light emitting diode of blue luminescence, and obtained white luminescence, especially optimized the chromaticity of white luminescence from the main light drawing side using the light emitting device of a flip chip mold, and its manufacture approach.

[0002]
[Description of the Prior Art]The light emitting diode (it is hereafter described as "LED") of blue luminescence becomes these days, and a product with high luminescence brightness came to be obtained by using GaN system compound semiconductors, such as GaN, GaAlN, InGaN, and InAlGaN. And formation of the high-definition full color image which makes three of such LED 1 dot was attained with the combination of LED of this blue (B), and LED of the red (R) from the former, and green (G) luminescence.
[0003]Since R, G, and B (blue) of light in three primary colors are required for a full color response in the field of LED, the much more development and amelioration of LED of these luminescent color are main. The attempt which is

going to attain white luminescence which is one of these, for example, is obtained only by composition of R, G, and B by single LED is also already made. There are some which were indicated by JP,7-99345,A as one of such the attempts.

[0004]LED given in this official report is taken as the so-called type of the LED lamp closed with resin (not shown) including mounting section 51a of the leadframe 51 which carries the luminescence chip 50, as shown in the schematic diagram of drawing 4. And in order to make luminescence wavelength of the luminescence chip 50 into the luminescent color which changed and is different, it has the configuration which closed surrounding mounting section 51a of the luminescence chip 50 by the resin 52 containing a fluorescent material. That is, while covering with the conventional LED lamp including the point of the leadframe which carries a luminescence chip, it replaces with what was being closed by the monolayer of the epoxy resin which serves also as a lens function, and the resin layer for wavelength conversion is formed in the circumference of a luminescence chip, and the surroundings of it are closed with an epoxy resin.

[0005]Moreover, it replaced with the LED lamp which carries a luminescence chip in the mounting section of drawing 4, and carries out a resin seal to a shell mold, and on the submounting component, the applicant for this patent proposed the semiconductor device of white luminescence which closed the surroundings of the light emitting device of the flip chip mold which mounted by placing the electrode by the side of p and n upside down with the resin package containing a fluorescent material, and applied as Japanese Patent Application No. No. 3788 [11 to]. Also in the semi-conductor luminescence equipment concerning this application, wavelength conversion of the blue luminescence from a light emitting device is carried out with a fluorescent material, and white luminescence is possible.

[0006]

[Problem(s) to be Solved by the Invention]Since the inner surface of mounting section 51a which carries the luminescence chip 50 is used as a light reflex side in the case of an LED lamp, it is effective to make mounting section 51a into the shape of a earthenware mortar like the example of a graphic display. In this case, since resin 52 is poured into mounting section 51a by the dispenser, it is dramatically difficult to control that thickness by high degree of accuracy, and it is impossible in the actual condition to make it the predetermined value which had the thickness A between the top face of the luminescence chip 50 and the front face of the resin 52 containing a fluorescent material set up.

[0007]Here, a substrate is turned upward for it to be a semi-conductor light emitting device using the GaN system compound semiconductor with which the luminescence chip 50 uses sapphire as a substrate, and the top face turns into the main light drawing side where luminescence brightness is the highest. If the thickness A of the resin 52 which, on the other hand, contains the fluorescent material which covers the top face of the luminescence chip 50 varies for every product, the conversion efficiency of the light from the luminescence chip 50 will serve as an ununiformity, and the pure target white luminescence will not be obtained. That is, the rate that blue luminescence from the luminescence chip 50 is changed into yellowish green becomes high, and it becomes the luminescent color which will seemingly be green, so that the thickness A of resin 52 is larger than a proper value, and if Thickness A is smaller than a proper value, it will become the luminescent color which blue cut. Thus, by the method filled up with the resin 52 which carries the luminescence chip 50 in mounting section 51a of a leadframe 51, and contains a fluorescent material by the dispenser, since the entropy of the conversion efficiency by the fluorescent material cannot be attained, there is a field which is not suitable as semi-conductor luminescence equipment of white luminescence.

[0008]On the other hand, after carrying out mounting loading of the light emitting device at the substrate material in a wafer condition, the metal mold

which wraps in the whole perimeter of this light emitting device is set, and a resin package can be formed by pouring resin into this metal mold what closes the circumference of the light emitting device of the flip chip mold of application of the point by the applicant for this patent with the resin package of fluorescent material content. By such formation approach of a resin package, the thickness of a resin package is uniformly decided with the configuration of metal mold. Therefore, in the final product after dicing, the resin package of almost uniform thickness by which creation was carried out to the surroundings of a light emitting device with metal mold should be formed.

[0009]However, since it is made from what mixed various kinds of fluorescent materials, for example by making an epoxy resin into the ground, the optimal process condition by metal mold changes variously with the mixing concentration of a fluorescent material, or the magnitude of a particle. For example, it is dramatically difficult to have delicate effect on the thickness of the resin package after hardening shaping from the melting temperature of resin, the relation of annealing hardening, etc., and to make thickness of the fabricated resin package into a design value about all products.

[0010]Thus, in the case where the light emitting device of a flip chip mold is closed by the resin of fluorescent material content, when pouring resin into mounting section 51a of the leadframe 51 shown by drawing 4 by the dispenser, the entropy of the thickness of the resin which carries out the coat of the main light drawing side of a light emitting device can be carried out to some extent. However, even if it is the light emitting device of a flip chip mold, it is not avoided that the thickness of the resin containing a fluorescent material differs delicately for every product. And since the thickness of the resin containing a fluorescent material influences a wavelength conversion rate greatly, the yield tends to fall from the field of manufacture of the product of white luminescence pure only by forming a resin package with metal mold.

[0011]This invention aims at offering the semi-conductor luminescence equipment with which the thickness of the resin layer which carries out wavelength conversion of the light from the main light drawing side of the light emitting device of a flip chip mold white is optimized, and pure white luminescence is obtained, and its manufacture approach.

[0012]

[Means for Solving the Problem]This invention carries out the laminating of the compound semiconductor to the front face of the substrate of light transmission nature, and forms the electrode by the side of p and n in the front-face side of said compound semiconductor. It is semi-conductor luminescence equipment containing the semi-conductor light emitting device of the flip chip mold which carried out flow loading of the electrode by the side of said p and n at the component side, and made the rear-face side of said substrate the main light drawing side. The main light drawing side of said substrate is covered with the wavelength conversion layer of the light transmission nature containing the fluorescent material for wavelength conversion at least, and it is characterized by carrying out polish generating of the front face of said wavelength conversion layer so that it may become parallel to said main light drawing side.

[0013]Moreover, the manufacture approach of ******** for manufacturing such semi-conductor luminescence equipment(1) The process which carries out flow loading of the electrode by the side of said p and n as a position in which the substrate of said light emitting device turns to a top at a flow substrate side, respectively, (2) The process which carries out the coat of the surroundings of said light emitting device with the resin ingredient containing the fluorescent material for wavelength conversion including the main light drawing side formed as a field said substrate turned [field] to the top at least, (3) -- the process which grinds the top face of said resin ingredient so that it may become parallel to the main light drawing side of said substrate, and (4) -- it is characterized by including the process which carries out the dicing of said flow substrate, and chip-izes it.

[0014]
[Embodiment of the Invention]Invention according to claim 1 carries out the laminating of the compound semiconductor to the front face of the substrate of light transmission nature. It is semi-conductor luminescence equipment containing the semi-conductor light emitting device of the flip chip mold which formed the electrode by the side of p and n in the front-face side of said compound semiconductor, and carried out flow loading of the electrode by the side of said p and n at the component side, and made the rear-face side of said substrate the main light drawing side. The main light drawing side of said substrate is covered with the wavelength conversion layer of the light transmission nature containing the fluorescent material for wavelength conversion at least. It is semi-conductor luminescence equipment characterized by carrying out polish generating of the front face of said wavelength conversion layer so that it may become parallel to said main light drawing side. Since the thickness of the wavelength conversion layer which covers the main light drawing side can be equalized, it has an operation that luminescence which can carry out entropy of the wavelength conversion rate of the light from the main light drawing side, and does not have chromaticity unevenness is obtained.
[0015]Invention according to claim 2 is semi-conductor luminescence equipment according to claim 1 characterized by said light emitting device constituting said compound semiconductor as a GaN system compound semiconductor, using the sapphire of transparence as said substrate, and has the operation of changing blue luminescence of the high brightness of a GaN system compound semiconductor into white luminescence, and making it emit light by the wavelength conversion layer of fluorescent material content.
[0016]invention according to claim 3 -- the manufacture approach of semi-conductor luminescence equipment according to claim 1 or 2 -- it is -- (1) -- with the process which carries out flow loading of the electrode by the side of said p and n as a position in which the substrate of said light emitting device turns to a top at a flow substrate side, respectively(2) The process which carries out the coat of the surroundings of said light emitting device with the resin ingredient containing the fluorescent material for wavelength conversion including the main light drawing side formed as a field said substrate turned [field] to the top at least, (3) The process which grinds the top face of said resin ingredient so that it may become parallel to the main light drawing side of said substrate, (4) It is the manufacture approach of the semi-conductor luminescence equipment characterized by including the process which carries out the dicing of said flow substrate, and chip-izes it. While wavelength conversion light without chromaticity unevenness is obtained by grinding a resin ingredient so that it may become the main light drawing side and parallel, and forming a wavelength conversion layer, also whenever [wavelength conversion] can be adjusted by adjusting the amount of polishes, and it has an operation that adjustment of the color tone of the luminescent color can also be performed free.

[0017]Hereafter, the gestalt of operation of this invention is explained based on a drawing.
[0018]Drawing 1 is outline drawing of longitudinal section of the semi-conductor luminescence equipment by the gestalt of 1 operation of this invention.

[0019]Like a graphic display, the semi-conductor luminescence equipment of this invention uses as the main members the resin package 4 of the transparence closed including the mounting substrate 1, the submounting component 2 carried on it, the light emitting devices 3 carried on it, and these submounting components 2 and light emitting devices 3. And the wavelength conversion layer of the fluorescent material for whitening is formed in the surroundings of a light emitting device 3, respectively so that it may mention later.
[0020]The mounting substrate 1 is insulation and forms in front flesh-side both sides of the mounting substrate 1 with plating through this slit using what cut the slit open to the substrate material of a wafer condition like the

semi-conductor light emitting device of the conventional flip chip mold, covering Electrodes 1a and 1b. Moreover, mounting of the submounting component 2 and a light emitting device 3, and after wirebonding, the resin package 4 closes the front face of the substrate material of a wafer condition by resin, and creation is carried out by the dicing of a final process as the mounting substrate 1 and the resin package 4 of a configuration of a graphic display.
[0021]The submounting component 2 is what used silicon substrate 2a of n mold, and forms in the base of this silicon substrate 2a n electrode 2b by which flow loading is carried out at electrode 1a of the mounting substrate 1. Moreover, 2d of n lateral electrodes which contact p lateral electrode 2c in contact with the p type semiconductor field formed in a part of this silicon substrate 2a to a n-type-semiconductor field is formed in the top face of silicon substrate 2a, respectively.
[0022]A light emitting device 3 is LED of blue luminescence using the GaN system compound semiconductor stated by the term of the conventional technique of high brightness. This light emitting device 3 carries out the laminating of n type layer of GaN, the barrier layer of InGaN, and the p type layer of GaN to the front face of substrate 3a made from sapphire. And conventionally, a part of p type layer was etched, n type layer was exposed, n lateral electrode 3b was formed in the front face of this exposed n type layer, p lateral electrode 3c was formed in the front face of p type layer, p lateral electrode 2c of the submounting component 2 was attained to in n lateral electrode 3b, and p lateral electrode 3c is joined to 2d of n lateral electrodes of the submounting component 2 through a bump electrode as everyone knows, respectively.

[0023]Furthermore, bonding of the wire 5 is carried out between p lateral electrode 2c of the submounting component 2, and electrode 1b of the mounting substrate 1. In addition, the mounting substrate 1 is mounted in wiring substrates, such as electronic equipment, and makes it flow through a light emitting device 3 in a power circuit side through the submounting component 2 by carrying out mounting loading of each electrode 1a and 1b at the circuit pattern of this wiring substrate. Moreover, the resin package 4 is made from the epoxy resin of the light transmission nature currently used in the field of the LED lamp from the former.
[0024]Here, in this invention, the surroundings of a light emitting device 3 were covered with the wavelength conversion layer 6, and this wavelength conversion layer 6 is closed and protected with the resin package 4. The wavelength conversion layer 6 mixes the fluorescent material for changing blue luminescence of a light emitting device 3 white in an epoxy resin, as indicated also on the application descriptions of Japanese Patent Application No. No. 3788 [11 to] explained previously. Fluorescent dye, a fluorescent pigment, a fluorescent substance, etc. can be used for the fluorescent material which changes this blue luminescence into white luminescence, for example, (Y, Gd) 3(aluminum, Ga)5O12:Ce etc. is [that what is necessary is just what has the relation of the blue and the complementary color which are the luminescent color of a light emitting device 3] suitable for it.
[0025]Although the wavelength conversion layer 6 changes blue luminescence from a light emitting device 3 into white luminescence, it depends for the conversion efficiency on the thickness of the wavelength conversion layer 6. That is, if the wavelength conversion layer 6 is thicker than a predetermined value as mentioned above, it will become the luminescent color which green cut, if thinner than a predetermined value, blueness will serve as the strong luminescent color, and the light from the luminescence observation side of a part where thickness differs tends to serve as a color tone from which it separated from the white light. Therefore, the thickness of the wavelength conversion layer 6 is the thickness same in the omnidirection of a light emitting device 3, and it is desirable to set up so that it can change into the white light at the optimal effectiveness. However, as explained previously, it is dramatically difficult to fabricate the wavelength conversion layer 6 in uniform thickness from the field of the present

manufacturing technology.
[0026]On the other hand, in the light emitting device 3 by the GaN system compound semiconductor which sets the sapphire of transparence to substrate 3a, the great portion of luminescence from the barrier layer of InGaN is emitted from the top face of substrate 3a. That is, if the top face of substrate 3a turns into the main light drawing side in drawing 1 and blue luminescence from this main light drawing side is changed into pure white, white luminescence good as a whole will be obtained. Of course, although the wavelength conversion layer 6 is emitted from the side face of not only the main light drawing side but substrate 3a and light is emitted also from the formation part of the electrodes 3c and 3b by the side of p and n, the luminescence direction made into the object is upward in drawing 1, and the contribution to the purpose for spending of luminescence from these side-faces and electrode forming face side is comparatively small. Therefore, a thing satisfactory as pure white luminescence, then semi-conductor luminescence equipment is obtained in the light from the main light drawing side, and if thickness of the wavelength conversion layer 6 of the part which has covered this main light drawing side, i.e., the top face of substrate 3a of sapphire, is equalized, luminescence without chromaticity unevenness will be obtained. In addition, since the wavelength conversion layer 6 is closed also including the side-face side of a light emitting device 3, and an electrode forming face side, there is no change in carrying out wavelength conversion of the whole light emitting device 3 light of a from white.
[0027]Here, the fluorescent material which contained the wavelength conversion layer 6 in it is excited by blue luminescence, and is observed as white luminescence. In this case, since the thickness of the wavelength conversion layer 6 determines a wavelength conversion rate uniquely, it becomes an important factor whether the thickness of the wavelength conversion layer 6 which covers the front face of a light emitting device 3 being uniform, and its thickness are optimum values. On the other hand, when grinding the front face after this invention persons formed the wavelength conversion layer 6, they did the knowledge of the ability to carry out the entropy of the thickness between the main light drawing sides, and they drew the optimal thickness experientially further. The outline of the production process of the compound-ized component by the submounting component 2 and the light emitting device 3 is shown in drawing 2 in order.
[0028]In drawing 2, alignment of the electrodes 3c and 3b by the side of p and n is carried out to the bump electrodes 11a and 11b which formed beforehand in the substrate material 11 for submounting components the light emitting device 3 beforehand chip-ized by dicing, by the vacuum head, a light emitting device 3 is mounted in the substrate material 11, and chip junction is carried out (this drawing (a)). Subsequently, the resin ingredient 12 containing a fluorescent material is covered with spreading or metal mold for the whole light emitting device 3 (this drawing (b)). In spreading of this resin ingredient 12, or formation by metal mold, since irregularity is made on a front face like [in drawing] and uniform display flatness is not obtained, the top face of the resin ingredient 12 is ground by the polish head 13 (this drawing (c)). The compound-ized component by the submounting component 2 and light emitting device 3 which were shown in drawing 1 is obtained by carrying out the dicing of the substrate material 11 to the last by the dicer 14.
[0029]In such a production process, on the substrate material 11, it mounts so that the top face of substrate 3a of a light emitting device 3 may serve as a horizontal position, and the level revolution of the polish head 13 is carried out with high degree of accuracy by the polish process. Thereby, after a polish process, it becomes parallel, the resin ingredient, i.e., the top face of the wavelength conversion layer 6, after being ground with the top face of substrate 3a, relation, and the entropy of the thickness of the wavelength conversion layer 6 can be carried out with high degree of accuracy. Therefore, in response to uniform wavelength conversion efficiency, wavelength conversion of the whole main light drawing side of a light emitting device 3 light of a from is carried out

white altogether, and white luminescence with a uniform chromaticity is obtained.

[0030]Drawing 3 is data which obtained the relation of the thickness of the wavelength conversion layer 6 and the chromaticity coordinate x which were formed of the above polish process by location survey.
[0031]The thickness of the wavelength conversion layer 6 manufactured what was changed among 40 micrometers - 60 micrometers, made the light emitting device 3 by the GaN system compound semiconductor shown in drawing 1 turn on, and plotted the chromaticity coordinate x. The coordinate value of an x-coordinate carries out the increment in a linear mostly as the wavelength conversion layer 6 becomes thick so that clearly from this plot, and it turns out that clear correlation is between thickness t of the wavelength conversion layer 6, and the coordinate value of an x-coordinate. By adjusting thickness t of the wavelength conversion layer 6, coordinate x value of a chromaticity coordinate can be set up and, as a result, adjustment of a chromaticity also becomes possible from this.

[0032]Moreover, according to the data obtained by the plot diagram in drawing 3, the experimental formula of x values of a chromaticity-coordinate value (empirical formula) was $x=0.0035t+0.0867$. Therefore, thickness t of the wavelength conversion layer 6 can be beforehand drawn easily to the x-coordinate of a target chromaticity coordinate, and desired white luminescence can be obtained. In addition, about the y-coordinate in a chromaticity coordinate, the luminescence wavelength of the light emitting device of blue luminescence is dominant, and the correlation to white luminescence can be disregarded.

[0033]As mentioned above, since it grinds so that the thickness of the wavelength conversion layer 6 which covers the main light drawing side of a light emitting device 3 may be equalized, the conditions of the wavelength conversion same about all the light from the main light drawing side can be added, and good white luminescence which carried out entropy of the chromaticity is obtained. Moreover, by adjusting the amount of polishes of the resin ingredient 12 by the polish process in (c) of drawing 2, the color tone of white luminescence can also be adjusted free and it can use the optimal as a source of luminescence according to an application.
[0034]
[Effect of the Invention]In this invention, since the thickness of the wavelength conversion layer which covers the main light drawing side of a light emitting device can be equalized, the entropy of the wavelength conversion rate of the light from the main light drawing side can be carried out, and luminescence without chromaticity unevenness is obtained. Moreover, since polish adjusts the thickness of a wavelength conversion layer, thickness can be set as arbitration, it can adjust free, and by the case where the light emitting device of blue luminescence is used, pure white luminescence is obtained and a chromaticity can also be used as the light source replaced with the conventional fluorescent lamp etc.

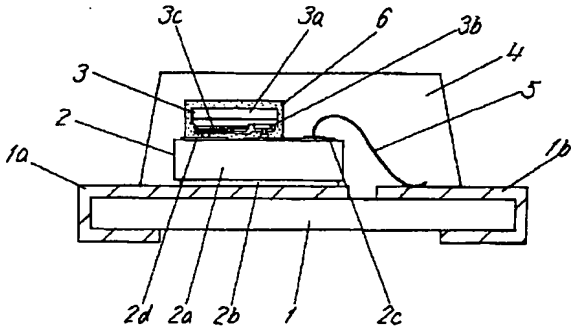
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]Outline drawing of longitudinal section of the semi-conductor luminescence equipment by the gestalt of 1 operation of this invention
[Drawing 2]The schematic diagram showing the production process of the compound-ized component by the submounting component and the light emitting device in order
[Drawing 3]The plot diagram showing the relation of the thickness of a wavelength conversion layer and the x-coordinate value of a chromaticity coordinate in the

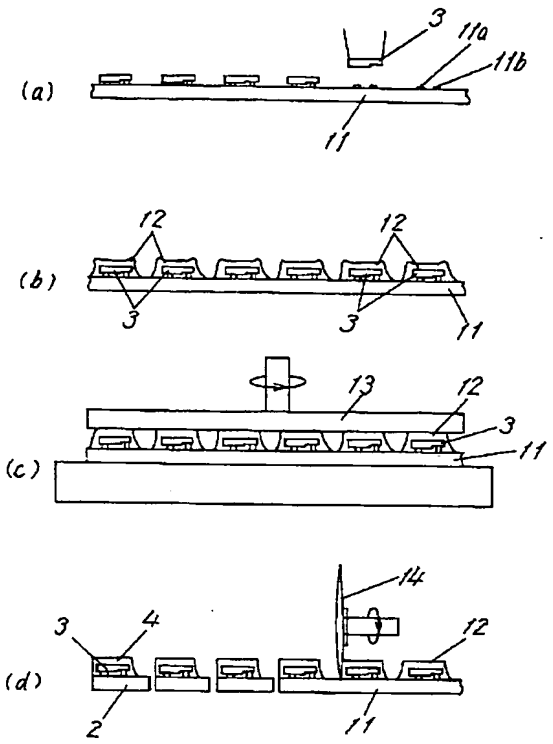
semi-conductor luminescence equipment of this invention
[Drawing 4]It is the conventional example which closed the light emitting device of blue luminescence by the wavelength conversion layer which mixed the fluorescent material in resin, and (a) is the outline drawing of longitudinal section.
(b) is an outline top view.
[Description of Notations]
1 Mounting Substrate
1a, 1b Electrode
2 SubMounting Component
2a Silicon substrate
2b n electrode
2c p lateral electrode
2d n lateral electrode
3 Light Emitting Device
3a Substrate
3b n lateral electrode
3c p lateral electrode
4 Resin Package
5 Wire
6 Wavelength Conversion Layer
11 Substrate Material
11a, 11b Bump electrode
12 Resin Ingredient
13 Polish Head
14 Dicer

DRAWINGS

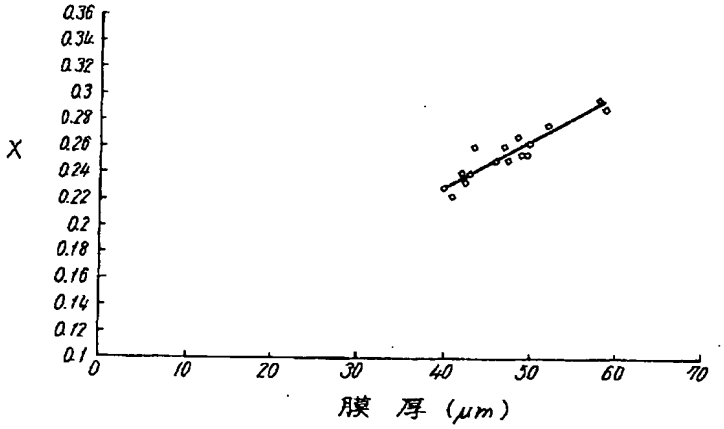
[Drawing 1]



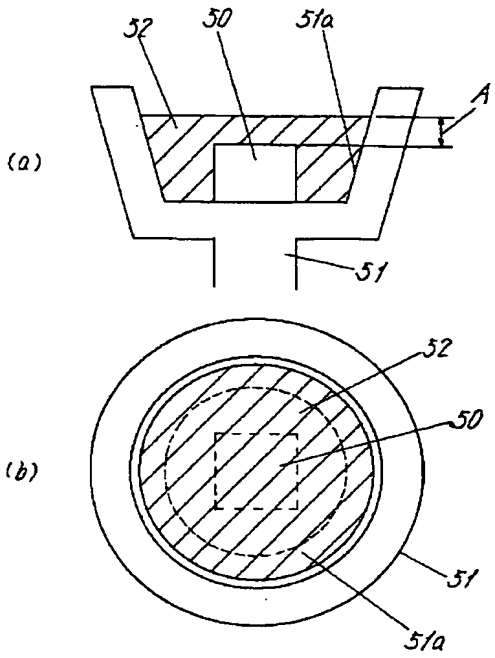
[Drawing 2]



[Drawing 3]



[Drawing 4]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(b)
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